IN THE CLAIMS:

This listing of the claims replaces all prior versions and listings of the claims in this application.

The text of all pending claims (including any withdrawn claims) is set forth below. Canceled and not entered claims are indicated with claim number and status only. The claims as listed below show added text with underlining and deleted text with ~~strikethrough~~. The status of each claim is indicated with one of (Original), (Currently amended), (Canceled), (Withdrawn), (Previously presented), (New), and (Not entered).

Please AMEND claims 1-23 in accordance with the following:

1. (Currently amended) An error correction coding apparatus comprising:

a parity check matrix generation unit ~~which~~ that generates a parity check matrix having elements arranged in rows and columns, with a number of the elements ~~having a value of 1~~ in each ~~row thereof,~~ of the rows having a value of 1 and all of the other elements in the rows having a value of 0, and a ~~predetermined~~ number of the elements ~~having a value of 1~~ in each ~~column thereof, and~~ of the columns having a value of 1 and all of the other elements in the columns having a value of 0;

a parity check matrix adjustment unit ~~which~~ that

______receives the parity check matrix from the parity check matrix generation unit,

______searches the parity check matrix for a cycle forming group of four elements having a value of 1 respectively positioned at ~~respective~~ vertexes of a rectangle, and ~~having a value of 1, and~~

______when ~~there is at least one~~ a cycle forming group is found in the parity check matrix, ~~replaces~~ generates an adjusted parity matrix without a cycle forming group therein by replacing the value of 1 of at least one element of the four elements of the cycle forming group with a value of 0, and replacing the value 0 of another element~~, to output an adjusted parity check matrix without a cycle forming group therein~~ in the same row or the same column as the one element of the four elements with a value of 1; and

~~an~~ a low-density parity-check (LDPC) coding unit ~~which~~ that

______receives the adjusted parity check matrix from the parity check matrix adjustment unit, receives an m-bit message word, and

~~to perform~~ performs LDPC coding of the m-bit message word based on the adjusted parity check matrix.

2. (Currently amended) The error correction coding apparatus of claim 1, wherein the parity check matrix adjustment unit comprises:

a matrix element check unit ~~which~~ that

receives the parity check matrix from the parity check matrix generation unit,

searches the parity check matrix for a plurality of cycle forming groups, and

outputs position information on positions (w1, x1), (w1, y1), (z1, x1), and (z1, y1) in the parity check matrix of ~~the respective~~ four elements having a value of 1 of a first cycle forming group found in the parity check matrix, and position information on positions (w2, x2), (w2, y2), (z2, x2), and (z2, y2) in the parity check matrix of ~~the respective~~ four elements having a value of 1 of a second cycle forming group found in the parity check matrix, with w_n and z_n identifying rows of the parity check matrix and x_n and y_n identifying columns of the parity check matrix; and

a matrix element shifting unit ~~which~~ that

receives the position information on the positions of the ~~respective~~ four elements of the first cycle forming group and the position information on the positions of the ~~respective~~ four elements of the second cycle forming group from the matrix element checking unit,

horizontally shifts one element S_{ij} of the four elements having a value of 1 of the first cycle forming group, where i=w1 or z1 and j=x1 or y1, to ~~one~~ a position of (i, x2) ~~and~~ or (i, y2) in another column, and

horizontally shifts one element Q_{kl} of the four elements having a value of 1 of the second cycle forming group ~~existing on a~~ located in the same column to which the one element S_{ij} ~~is~~ was shifted, where k=w2 or z2 and l=x2 or y2, to a position of (k, j) in the same column from which the one element S_{ij} was shifted, thereby removing the first cycle forming group and the second cycle forming ~~groups~~ group from the parity check matrix;~~, and~~

wherein, when two other cycle forming groups are ~~present~~ found in the parity check matrix, the parity check matrix adjustment unit ~~operates~~ removes ~~them so as~~ the two other cycle forming groups to generate the adjusted parity check matrix without a cycle forming group therein.

3. (Currently amended) The error correction coding apparatus of claim 1, wherein the parity check matrix adjustment unit comprises:

a matrix element check unit ~~which~~ that

______receives the parity check matrix from the parity check matrix generation unit,

______searches the parity check matrix for a plurality of cycle forming groups, ~~existing in the parity check matrix,~~ and

______outputs position information on positions (w1, x1), (w1, y1), (z1, x1), and (z1, y1) in the parity check matrix of four elements ~~constituting~~ having a value of 1 of a first cycle forming group found in the parity check matrix, and position information on positions (w2, x2), (w2, y2), (z2, x2,) and (z2, y2) in the parity check matrix of four elements ~~constituting the~~ having a value of 1 of second cycle forming group found in the parity check matrix, with w_n and z_n identifying rows of the parity check matrix and x_n and y_n identifying columns of the parity check matrix; and

a matrix element shifting unit ~~which~~ that

______receives the position information on the positions of the ~~respective~~ four elements of the first cycle forming group and the position information on the positions of the ~~respective~~ four elements of the second cycle forming group from the matrix element checking unit, ~~and~~

______vertically shifts one element S_{ij} of the four elements having a value of 1 of the first cycle forming group, ~~wherein~~ where i=w1 or z1 and j=x1 or y1, to ~~one~~ a position of (w2, j) ~~and~~ or (z2, j) in another row, and

______vertically shifts one element Q_{kl} of the four elements having a value of 1 of the second cycle forming group ~~existing on a~~ located in the same row to which the one element S_{ij} ~~is~~ was shifted, where k=w2 or z2 and l=x2 or y2, to a position of (i, l) in the same row from which the one element Sij was shifted, thereby removing the first cycle forming group and the second cycle forming ~~groups~~ group from the parity check matrix;~~, and~~

wherein, when two other cycle forming groups are ~~present~~ found in the parity check matrix, the parity check matrix adjustment unit removes ~~them so as~~ the two other cycle forming groups to generate the adjusted parity check matrix without a cycle forming group therein.

4. (Currently amended) The error correction coding apparatus of claim 1, wherein the adjusted parity check matrix is a matrix H;

wherein the m-bit message word is denoted by k_i (i=1, 2,...m);

wherein the LDPC coding unit determines p bits of parity information x_i (i=1, 2,...p) ~~as~~ that are elements of ~~the~~ a matrix X satisfying the following equation:

~~H×M = 0~~

H×X = 0, ~~wherein~~ where X is ~~a~~ an (m+p) ×1 matrix $\begin{pmatrix} k_1 \\ k_2 \\ . \\ . \\ . \\ k_m \\ x_1 \\ x_2 \\ . \\ . \\ . \\ x_p \end{pmatrix}$; and

~~and~~ wherein the LDPC coding unit outputs a codeword having the parity information x_i (i=1,2...p) added to the m-bit message word k_i (i=1, 2,...m).

5. (Currently amended) The error correction coding apparatus of claim 2, wherein the matrix element shifting unit ~~receives the parity check matrix from the parity check matrix generation unit and~~ horizontally shifts ~~an~~ the one element S_{ij} ~~having a value of 1 of the first cycle forming group, wherein i=w1 or z1 and j=x1 or y1,~~ to a position of (i, x2) if an element already existing at a position of (i, y2) has a value of 1, or horizontally shifts the one element S_{ij} ~~has a value of 1 and is shifted~~ to ~~another~~ a position ~~when the~~ of (i, y2) if an element already existing at a position of (i, x2) has a value of 1~~exists at the shifted position~~.

6. (Currently amended) The error correction coding apparatus of claim 2, wherein if elements already existing at positions of (i, x2) and (i, y2) have a value of 1 for i of the one element S_{ij}, the matrix element shifting unit ~~receives the parity check matrix from the parity check matrix generation unit and shifts another element~~ selects a different one of the four elements having a value of 1 of the first cycle forming group~~, wherein i=w1 or z1 and j=x1 or y1, the element has~~ having a different value of ~~1 and is shifted~~ i as a different element S_{ij}, horizontally

shifts the different element S_{ij} to ~~another~~ a position ~~when the value of 1 exists at the shifted position~~ of (i, x2) if an element already existing at a position of (i, y2) has a value of 1, or horizontally shifts the different element S_{ij} to a position of (i, y2) if an element already existing at a position of (i, x2) has a value of 1.

7. (Currently amended) The error correction coding apparatus of claim 2, wherein the matrix element shifting unit ~~receives the parity check matrix from the parity check matrix generation unit and~~ horizontally shifts ~~an~~ the one element S_{ij} ~~having a value of 1 of the first cycle forming group, wherein i=w1 or z1 and j=x1 or y1,~~ to a position of (i, x2) if horizontally shifting the one element S_{ij} to a position of (i, y2) would create a new cycle forming group, or horizontally shifts the one element S_{ij} ~~has a value of 1 and is shifted~~ to ~~another~~ a position ~~when~~ of (i, y2) if horizontally shifting the one element S_{ij} to a position of (i, x2) would create a ~~third~~ new cycle forming group ~~is newly generated by the shift of the element S_{ij}~~.

8. (Currently amended) The error correction coding apparatus of claim 2, wherein if horizontally shifting the one element S_{ij} to a position of (i, x2) for i of the one element S_{ij} would create a new cycle forming group, and horizontally shifting the one element S_{ij} to a position of (i, y2) for i of the one element S_{ij} would also create a new cycle forming group, the matrix element shifting unit ~~receives the parity check matrix from the parity check matrix generation unit and shifts another element~~ selects a different one of the four elements having a value of 1 of the first cycle forming group~~, wherein i=w1 or z1 and j=x1 or y1, the~~ having a different value of i as a different element ~~having a value of 1 and is shifted~~ S_{ij}, horizontally shifts the different element S_{ij} to ~~another~~ a position ~~when~~ of (i, x2) if horizontally shifting the different element S_{ij} to a position of (i, y2) would create a ~~third~~ new cycle forming group, ~~is newly generated by the shift of~~ or horizontally shifts the ~~another~~ different element S_{ij} to a position of (i, y2) if horizontally shifting the different element S_{ij} to a position of (i, x2) would create a new cycle forming group.

9. (Currently amended) The error correction coding apparatus of claim 2, wherein if the matrix element shifting unit ~~receives the parity check matrix from the parity check matrix generation unit, shifts an element S_{ij} having element value 1 of the first cycle forming group, where i=w1 or z1 and j=x1 or y1, to another position, and when~~ is unable to remove the first cycle forming group and the second cycle forming group ~~are not removed~~ from the parity check

matrix, the matrix element shifting unit requests ~~from~~ the matrix element check unit position to output position information for ~~another pair of~~ two other cycle forming groups to ~~remove~~ be removed by the matrix element shifting unit.

10. (Currently amended) The error correction coding apparatus of claim 2, wherein~~,~~ ~~when~~ if the parity check matrix adjustment unit is unable to remove all cycle forming groups ~~existing in~~ from the parity check matrix, ~~are not removed,~~ the ~~parity check~~ matrix element shifting unit requests ~~from~~ the parity check matrix generation unit to generate a new parity check matrix to be input to the matrix element check unit.

11. (Currently amended) An error correction coding method comprising:

generating a parity check matrix having elements arranged in rows and columns, with a number of the elements ~~having a value of 1~~ in each ~~row thereof,~~ of the rows having a value of 1 and all of the other elements in the rows having value of 0, and a number of the elements ~~having a value of 1~~ in each ~~column thereof, and~~ of the columns having a value of 1 and all of the other elements in the columns having a value of 0;

~~receiving the parity check matrix,~~

searching the parity check matrix for a cycle forming group of four elements having a value of 1 respectively positioned at ~~the respective~~ vertexes of a rectangle; ~~and having a value of 1, and~~

when ~~there is at least one~~ a cycle forming group is found in the parity check matrix, generating an adjusted parity check matrix without a cycle forming group therein by replacing the value of 1 of at least one element of the four elements of the cycle forming group with a value of 0, and replacing the value 0 of another element~~, to output a adjusted parity check matrix without a cycle forming group therein~~ in the same row or the same column as the one element of the four elements with a value of 1; and

~~receiving the modified parity check matrix and receiving~~ performing low-density parity-check (LDPC) coding of an m-bit message word ~~to perform LDPC coding~~ based on the adjusted parity check matrix.

12. (Currently amended) The error correction coding method of claim 11, wherein the ~~receiving~~ searching of the parity check matrix comprises~~:~~

~~receiving the parity check matrix,~~

searching the parity check matrix for ~~the~~ a plurality of cycle forming groups, and

~~outputting~~ obtaining position information on positions (w1, x1), (w1, y1), (z1, x1), and (z1, y1) in the parity check matrix of ~~the respective~~ four elements having a value of 1 of a first cycle forming group found in the parity check matrix, and position information on positions (w2, x2), (w2, y2), (z2, x2), and (z2, y2) in the parity check matrix of ~~the respective~~ four elements having a value of 1 of a second cycle forming group found in the parity check matrix, with w_n and z_n identifying rows of the parity check matrix and x_n and y_n identifying columns of the parity check matrix;

wherein the generating of the adjusted parity check matrix comprises

horizontally shifting one element S_{ij} of the four elements having a value of 1 of the first cycle forming group, ~~wherein~~ where i=w1 or z1 and j=x1 or y1, to ~~one of~~ a position of (i, x2) ~~and~~ or (i, y2) in another column, and

horizontally shifting one element Q_{kl} of the four elements having a value of 1 of the second cycle forming group ~~existing on a~~ located in the same column to which the one element S_{ij} ~~is~~ was shifted, where k=w2 or z2 and l=x2 or y2, to a position of (k, j) in the same column from which the one element S_{ij} was shifted, thereby removing the first cycle forming group and the second cycle forming ~~groups~~ group from the parity check matrix; and

when two other cycle forming groups are found in the parity check matrix, repeating the ~~cycle forming group removing with respect~~ generating of the adjusted parity check matrix to remove the two ~~another~~ other cycle forming groups ~~to generate~~ from the ~~modified~~ parity check matrix.

13. (Currently amended) The error correction coding method of claim 11, wherein the ~~receiving~~ searching of the parity check matrix comprises~~:~~

~~receiving the parity check matrix,~~

searching the parity check matrix for a plurality of cycle forming groups, and

outputting position information on positions (w1, x1), (w1, y1), (z1, x1), and (z1, y1) in the parity check matrix of four elements ~~constituting~~ having a value of 1 of a first cycle forming group found in the parity check matrix, and position information on positions (w2, x2), (w2, y2), (z2, x2), and (z2, y2) in the parity check matrix of four elements ~~constituting~~ having a value of 1 of a second cycle forming group~~, thereby checking~~ found in the parity check matrix,

~~elements~~ with w_n and z_n identifying rows of the parity check matrix and x_n and y_n identifying columns of the parity check matrix;

wherein the generating of the adjusted parity check matrix comprises

vertically shifting one element S_{ij} of the four elements having a value of 1 of the first cycle forming group, ~~wherein~~ where i=w1 or z1 and j=x1 or y1, to ~~one~~ a position of (w2, j) ~~and~~ or (z2, j) in another row, and

vertically shifting one element Q_{kl} of the four elements having a value of 1 of the second cycle forming group ~~existing on a column to~~ located in the same row to which the one element S_{ij} ~~is~~ was shifted, ~~wherein~~ where k=w2 or z2 and l=x2 or y2, to a position of (i, l) in the same row from which the one element S_{ij} was shifted, thereby removing the first cycle forming group and the second cycle forming ~~groups~~ group from the parity check matrix; and

when two other cycle forming groups are found in the parity check matrix, repeating the ~~shifting one element with respect~~ generating of the adjusted parity check matrix to remove the two ~~another~~ other cycle forming groups ~~to generate~~ from the ~~modified~~ parity check matrix.

14. (Currently amended) The error correction coding method of claim 11, wherein the adjusted parity check matrix is a matrix H;

wherein the m-bit message word is denoted by k_i (i=1, 2,...m);

wherein the ~~receiving the modified parity check matrix~~ performing of the LDPC coding comprises determining ~~the~~ p bits of parity information x_i~~, where~~ (i=1,2...p)~~, as~~ that are elements of ~~the~~ a matrix X satisfying the following equation:

~~H×M = 0~~

H×X = 0, ~~wherein~~ where X is ~~a~~ an (m+p) ×1 matrix $\begin{pmatrix} k_1 \\ k_2 \\ . \\ . \\ . \\ k_m \\ x_1 \\ x_2 \\ . \\ . \\ . \\ x_p \end{pmatrix}$; and

~~and outputting~~ wherein the performing of the LDPC coding further comprises generating a codeword having the parity information x_i (i=1,2...p) added to the m-bit message word k_i (i=1, 2,...m).

15. (Currently amended) The error correction coding method of claim 12, wherein the horizontally shifting of the one element S_{ij} comprises ~~receiving the parity check matrix, and when the value of 1 exists at the shifted position when~~ horizontally shifting the one element S_{ij} ~~has a value of 1 of the first cycle forming group, wherein i=w1 or z1 and j=x1 or y1, and~~ to a position of (i, x2) if an element already existing at a position of (i, y2) has a value of 1, or horizontally shifting the one element S_{ij} ~~having a value of 1~~ to ~~another~~ a position of (i, y2) if an element already existing at a position of (i, x2) has a value of 1.

16. (Currently amended) The error correction coding method of claim 12, wherein if elements already existing at positions (i, x2) and (i, y2) have a value of 1 for i of the one element S_{ij}, the horizontally shifting of the one element S_{ij} comprises ~~receiving the parity check matrix C, and if the element value 1 exists at the shifted position in the case of shifting an element S_{ij}~~ selecting a different one of the four elements having ~~element~~ a value of 1 of the first cycle forming group~~, where i=w1 or z1 and j=x1 or y1, and shifting another~~ having a different value of i as a different element S_{ij}, horizontally shifting the different element ~~having element value 1~~ S_{ij} to ~~another~~ a position of (i, x2) if an element already existing at a position of (i, y2) has a value of 1,

or horizontally shifting the different element S_{ij} to a position of (i, y2) if an element already existing at a position of (i, x2) has a value of 1.

17. (Currently amended) The error correction coding method of claim 12, wherein the horizontally shifting of the one element S_{ij} comprises ~~receiving the parity check matrix C, and if a third cycle forming group is generated in the case of shifting an~~ horizontally shifting the one element S_{ij} ~~having element value 1 of the first cycle forming group, where i=w1 or z1 and j=x1 or y1, and~~ to a position of (i, x2) if horizontally shifting the one element S_{ij} to a position of (i, y2) would create a new cycle forming group, or horizontally shifting the one element S_{ij} ~~having element value 1~~ to ~~another~~ a position of (i, y2) if horizontally shifting the one element S_{ij} to a position of (i, x2) would create a new cycle forming group.

18. (Currently amended) The error correction coding method of claim 12, wherein if horizontally shifting the one element S_{ij} to a position of (i, x2) for i of the one element S_{ij} would create a new cycle forming group, and horizontally shifting the one element S_{ij} to a position of (i, y2) for i of the one element S_{ij} would also create a new cycle forming group, the horizontally shifting of the one element S_{ij} comprises ~~receiving the parity check matrix C, and wherein, when a third cycle forming group is generated in the case of shifting an element S_{ij}~~ selecting a different one of the four elements having ~~element~~ a value of 1 of the first cycle forming group~~, where i=w1 or z1 and j=x1 or y1,~~ having a different value of i as a different element S_{ij}, horizontally shifting ~~another~~ the different element ~~having element value 1~~ S_{ij} to ~~another~~ a position of (i, x2) if horizontally shifting the different element S_{ij} to a position of (i, y2) would create a new cycle forming group, or horizontally shifting the different element S_{ij} to a position of (i, y2) if horizontally shifting the different element S_{ij} to a position of (i, x2) would create a new cycle forming group.

19. (Currently amended) The error correction coding method of claim 12, wherein ~~the shifting one element comprises receiving the parity check matrix C, shifting an element S_{ij} having element value 1 of the first cycle forming group, where i=w1 or z1 and j=x1 or y1, to another position and, when~~ if the first cycle forming group and the second cycle forming group ~~are not~~ cannot be removed in the generating of the adjusted parity check matrix, ~~receiving another pair of~~ the searching of the parity check matrix further comprises obtaining position information for

two other cycle forming groups to ~~perform removing the pair of cycle forming groups~~ be removed in the generating of the adjusted parity check matrix.

20. (Currently amended) The error correction coding method of claim 12, ~~further comprising generating a new parity check matrix when~~ wherein if all cycle forming groups ~~existing in~~ cannot be removed from the parity check matrix ~~are not removed and repeating the receiving the~~ in the generating of the adjusted parity check matrix, ~~shifting one element S_{ij}, and repeating the cycle forming group removing~~ the generating of the adjusted parity check matrix further comprises requesting generation of a new parity check matrix to be searched in the searching of the parity check matrix.

21. (Currently amended) A computer readable medium encoded with processing instructions for performing an error correction coding method comprising:

generating a parity check matrix having elements arranged in rows and columns, with a number of the elements ~~having a value of 1~~ in each ~~row thereof,~~ of the rows having a value of 1 and all of the other elements in the rows having a value of 0, and a number of the elements ~~having a value of 1~~ in each ~~column thereof, and~~ of the columns having a value of 1 and all of the other elements in the columns having a value of 0;

~~receiving the parity check matrix,~~

searching the parity check matrix for a cycle forming group of four elements~~, the four elements~~ having a value of 1 respectively positioned at ~~the respective~~ vertexes of a rectangle; ~~and having a value of 1, and~~

when ~~there is at least one~~ a cycle forming group is found in the parity check matrix, replacing the value of 1 of at least one element of the four elements of the cycle forming group with a value of 0, and replacing the value 0 of another element~~,~~ in the same row or the same column as the one element of the four elements with a value of 1 to ~~output a~~ generate an adjusted parity check matrix without a cycle forming group therein; and

~~receiving the modified parity check matrix and receiving a~~ performing low-density parity-check (LDPC) coding of an m-bit message word ~~to perform LDPC coding~~ based on the adjusted parity check matrix.

22. (Currently amended) An error correction coding apparatus comprising:

a parity check matrix generator ~~which~~ that generates a parity check matrix~~,~~ having ~~one or more~~ elements arranged in rows and ~~one or more~~ columns, with a number of the elements ~~of a first value~~ in each ~~row~~ of the rows having a first value and all of the other elements in the rows having a second value different from the first value, and a number of the elements in each ~~column~~ of the columns having the first value and ~~a number~~ all of the other elements ~~of a~~ in the columns having the second value;

a parity check matrix modifier ~~which~~ that

receives the parity check matrix from the parity check matrix generator,

searches the parity check matrix for a cycle forming group of four elements having the first value respectively positioned at ~~each of the verticies~~ vertexes of a rectangle, and ~~being of the first value and,~~

when ~~at least one~~ a cycle forming group is found in the parity check matrix, ~~replaces~~ replaces the first value of at least one element of the four elements of ~~each of~~ the ~~one ore more~~ cycle forming ~~groups~~ group with the second value, and replaces the second value of another element in the same row or the same column as the one element of the four elements with the first value to ~~output~~ generate a modified parity check matrix without a cycle forming group therein; and

a ~~low density parity code~~ low-density parity-check (LDPC) coder ~~which~~ that

receives the modified parity check matrix from the parity check matrix modifier,

receives an m-bit message word, and

~~to perform~~ performs LDPC coding ~~and performs LDPC coding using~~ of the m-bit message word based on the ~~adjusted~~ modified parity check matrix.

23. (Currently amended) A computer readable ~~storage~~ medium encoded with processing instructions for performing an error correction coding method comprising:

generating a parity check matrix~~,~~ having ~~one or more~~ elements arranged in rows and ~~one or more~~ columns, with a number of the elements ~~of a first value~~ in each ~~row~~ of the rows having a first value and all of the other elements in the rows having a second value different from the first value, and a number of the elements in each ~~column~~ of the columns having the first value and ~~a number~~ all of the other elements ~~of a~~ in the columns having the second value;

searching the parity check matrix for a cycle forming group of four elements having the first value respectively positioned at ~~each of the vertices~~ vertexes of a rectangle; and ~~being of the first value and,~~

when ~~at least one~~ a cycle forming group is found in the parity check matrix, ~~replaces~~ replacing the first value of at least one element of the four elements of ~~each of~~ the ~~one or more~~ cycle forming ~~groups~~ group with the second value, and replacing the second value of another element in the same row or the same column as the one element of the four elements with the first value to ~~output~~ generate a modified parity check matrix without a cycle forming group therein; and

~~receiving~~ performing low-density parity-check (LDPC) coding of an m-bit message word ~~to perform low density parity code (LDPC) coding and performing LDPC coding using~~ based on the ~~adjusted~~ modified parity check matrix.